euthanized minutes before the impact. As in previous experiments, eight sensors were placed equidistant about the spine in two columns of four. Unlike other experiments, these tests employed six newly design Piezo-film sensors as well as two of the older style bone conducting sensors. Unfortunately, the new sensors were not as responsive as the older bone conducting ones and have been left out of the analysis. The results from these tests will be from signatures recorded from the two bone conducting sensors. FIGS. **24** and **25** show typical impact signatures from form the pilot study. The graph on the left is a 2800 ft/sec 7.62 round left lateral chest impact from a live anesthetized animal. The graph on the right is the same parameters from a freshly euthanized animal.

Similarly, FIGS. **26** and **27** show the frequency spectrum of the above impact signatures: live in FIG. **26** and freshly euthanized in FIG. **27**. The FFTs below are 1024 point FFTs using 75 data points and zero-padding. The Y-axis is always in arbitrary units which can be compared between graphs in which similar processing has been performed. After completing the pilot study, the remaining animals were impacted directly after euthanasia. It should be noted that the sensor used in these recordings has a particular resonance at 17,000 Hz explaining the large frequency response in that area on the graphs in FIGS. **26** and **27**. While there was some signal present in that frequency region, care must be used in characterizing the frequency response of the sensors as it affects the analysis of the impact signatures.

Mine surrogates containing surrogates containing 100 and 200 grams of C4 explosive were used against cadavers with and without a blast suit. Sensors were affixed to the cadavers using superglue in the same configuration as FIG. **21**. Signals were recorded at 50,000 samples per second on each channel. FIG. **28** shows the impact signal from a 200-gram blast with a blast suit. The subject's nose was 55 centimeters (measured radially) from the center of the mine surrogate. The response from the sensor seems to be that of a second-order system in response to a step function. A second order system consists of a mass, a spring and a dashpot (shock absorber). FIG. **28** shows a longer duration event lasting well beyond 600 milliseconds. Examination of the recording indicates higher frequency components for the first 150 milliseconds and slower frequencies after 150 milliseconds. It is likely that part of the slower frequency waves are made up of the tissue deformation waves. An FFT on the first 170 milliseconds of the blast is shown in FIG. **29**. Much of the response to this type of blast is in the lower frequencies, less than 200 Hertz. This seems to indicate that the surface of the body couples with the primary low frequency blast wave.

Data was also acquired for simulated normal activity to determine key characteristics of signals from running, hopping and a significant jolt. Human data was collected while the subject ran and hopped in place. The jolt signature resulted in a jump off a 30 inch table. FIG. **30** is the resultant signal from the 30 inch jump. FIG. **31** is the frequency domain spectrum produced by the FFT. The frequency spectrum shows that this jolt to the body produces two significant frequencies: a larger amplitude component at 293 Hertz and a smaller but significant frequency at 586 Hertz. This latter frequency is in the range produced by the bullet impacts. Of the three 'normal' recordings, only the big jump proved to contain frequencies in the range of those produced by the bullet impacts.

Bench testing of the BIDS circuit included converting the digital impact signatures in analog voltages and feeding them through the circuit. The impact threshold settings were set so as to discriminate between the swine impacts and the normal human movement signatures. Setting the threshold is somewhat arbitrary since the voltage at that point is dependent upon the initial amplification from the input amplifier. More important is the relative voltage levels between the smallest detectable impact and the largest normal movement signal. FIG. **32** shows a comparison of two signals that have been filtered using the 3 pole 5000 Hertz high pass filter in the BIDS circuit. The first trace 400 is the time domain signal from a hind limb, 5.56 caliber impact at 1300 ft/sec; the second trace **450** is the time domain signal from the big jump in FIG. **30**. FIG. **32** shows the ability to easily discriminate the weakest bullet impact recorded from the strongest 'normal' activity recording.

Although described with reference to preferred embodiments of and tests conducted in connection with the invention, it should be readily understood that various changes and/or modifications could be made to the invention without departing from the spirit thereof. For example, different types of signal processing circuitry for determining location of impacts or a target are shown in U.S. Pat. No. 4,349,728 which is incorporated herein by reference. Certainly, other logic elements could be used in the BIDS system without departing from the scope of the invention. In general, it is important that the sensor system of the invention can be used to detect, verify and locate a ballistic impact on a body, particularly an impact which causes an injury to the body. Detection and location information can be transmitted to a remote location, with this information being potentially used to enhance the ability to appropriately respond to counter the injury. In any case, the invention is only intended to be limited by the scope of the following claims.

We claim:

1. A wearable ballistic impact detection system for detecting impacts to a body of an individual comprising:

a plurality of spaced sensors adapted to be supported by the body for detecting ballistic impact vibrations which are converted into electrical signals; and

electronic logic circuitry receiving the electrical signals and determining both an occurrence of a ballistic impact to the body at a location spaced from the plurality of sensors and the location of the impact, wherein the electronic logic circuitry comprises:

at least one filter electrically connected to said plurality of sensors for receiving the electrical signals and transmitting a filtered electrical signal of interest; and

a group of electronic components for determining if the signal of interest has frequency and amplitude characteristics of an impact that causes injury to the body.

2. The system of claim **1**, wherein the electronic logic circuitry further comprises: an input buffer amplifier.

3. The system of claim **1**, wherein the at least one filter constitutes a high pass filter.

4. The system of claim **1**, wherein the group of electronic components includes a rectifier for rectifying the signal of interest received from the at least one filter.

5. The system of claim **1**, wherein said group of electronic components includes a low pass filter.

6. The system of claim **1**, wherein said group of electronic components includes a peak hold circuit for measuring a peak voltage from the electrical signal of interest.

7. The system of claim **1**, wherein the electronic logic circuitry further comprises: a logarithmic amplifier.

8. The system of claim **1**, further comprising: an article of clothing supporting the plurality of sensors at spaced locations on the body.

9. The system of claim **8**, wherein the article of clothing constitutes body armor.